SKYLAB/EREP APPLICATION TO ECOLOGICAL, GEOLOGICAL AND OCEANOGRAPHIC INVESTIGATIONS OF DELAWARE BAY

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March 13, 1974
Bi-Monthly Technical Letter Progress Report
for period February 1974 - March 1974
Contract No. NAS 1 - 12304

Prepared for
NASA LANGLEY RESEARCH CENTER
HAMPTON, VA. 23665

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May 24, 1976
Report on Significant Results
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Contract NAS1-12304

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SIGNIFICANT RESULTS

Film products from the Skylab/EREP S190A and S190B camera systems, and digital tapes from the S192 multispectral scanner have been analyzed using multispectral digital and direct visual interpretation techniques. Useful results were obtained for the following applications: mapping coastal land-use; inventorying coastal vegetation; assessing environmental impact on vegetation; mapping coastal erosion; monitoring suspended sediment concentrations; charting surface current circulation; locating coastal frontal systems; tracking surface slicks; studying the dispersion of ocean dump plumes; and monitoring ship traffic.

Skylab film products were visually analyzed to identify and map ten land-use and vegetation categories at a scale of 1:125,000. Comparison of these thematic maps with USGS-CARETS land-use maps, resulted in classification accuracies ranging from 75% to 99%. Classification accuracies obtained by comparison of S192 derived thematic maps of land-use with USGS-CARETS maps in southern Delaware ranged from 44% to 100%. The resolutions of the S190A, S190B and S192 systems were 20-40m, 10-20m, and 70-100m, respectively.

Bi-Monthly Technical Letter
Progress Report

1. Status

EREP was activated during the following Skylab overpasses of Delaware Bay:

Track	Revolution	Date	Approximate Time(EDT)	Cloud Cover
61	1197	Aug. 5	11 a.m.	30%
43	1747	Sept. 12	1 p.m.	10%
43	1818	Sept. 17	11 a.m.	60%

Large amounts of ground truth were collected during each overpass, including water sampling from boats and helicopters. However, of the three Skylab/EREP attempts only the pass on September 12, 1973, produced imagery free of major cloud dover. Fortunately, we were able to gather considerable amounts of ground truth from boats and low-altitude aircraft for that overpass.

The Skylab/EREP data products evaluated include magnetic tapes from the multispectral scanner (S192), containing thirteen spectral bands ranging from 0.4 microns to 12.5 microns; a 5 inch format color transparency from the S190B Earth Terrain Camera; and six sets of 70 millimeter positive transparencies from the S190A Multispectral Photographic facility.

In S192 band 1, a general lack of contrast is observed. This is due to both low atmospheric transmission and radiance reflected back into the scanner from the atmosphere (path radiance).

The S192's data is recorded on a height density digital tape (HDDT) having 10,000 b.p.i. Another notable fact is the conical line scan pattern used by the S192. Single band imagery produced directly from the HDDT has this same conical pattern making ready identification of small targets (based on spatial features) extremely difficult. The S192 HDDT

data must be preprocessed before any usable data products can be generated. These steps include: (1) transferring raw data from HDDT to standard 9 track CCT and (2) using this tape to generage another CCT whose data is 'linearized' (i.e., as if scan were normal to direction of spacecraft motion). This data although linearized still has the distortions due to earth rotation.

Another notable feature are the various noise patterns observable in many of the S192 bands. Noise characteristics observed in the unfiltered S192 imagery are as follows:

a. Detector Noise: A very low frequency (f) noise source. It has an 1/f characteristic. It shows up as a slow variation in scanner gain and offset and is most noticeable in the thermal band 13. It could be easily removed by referencing the two calibration sources and determining what gain and offset to add to the calibration signals (also to the video) to force them to remain at a constant level.

b. Cooler Piston Noise: Most noticeable noise over Delaware Bay is in band 5. It has a fundamental frequency in the range of 16 to 18 Hz (i.e., a period of about 6 scan lines). It could be removed by simulating a notch filter.

c. Power Inverter: It produces a herring bone pattern which requires close analysis over homogeneous areas (i.e. water) to be observed. It has a fundamental frequency whose period is approximately 16 resolution elements. It could also be removed by digital simulation of a notch filter. This noise is most noticeable in band 4, and to some extent in bands 1, 2, 3, 5, 7, and 8.

d. Sync Drop-Outs. Poor signal to noise ratio on sync signal causes the film recorder to lose timing signal resulting in the major banding observed in bands 3 and 4.

Noise problems are under intensive study by NASA. Noise-filtered tapes are expected to become available in the near future.

2. Recommendations

NASA should provide noise-filtered S192 tapes as soon as possible.

3. Expected Accomplishments

During the next reporting period we expect to complete analysis of the MSS tapes and photographs of the September 12, 1973, Skylab overpass. Maps of coastal vegetation, land use, water turbidity and current circulation will be prepared during the subsequent two months.

4. Significant Results

NASA's ERTS-1 satellite and Skylab-EREP have both provided imagery suitable for investigating coastal vegetation, land use, current circulation, water turbidity, waste disposal, and sea state. Based on high-contrast targets, such as piers and breakwaters, the ERTS-1 MSS seems to have a resolution of 70-100 meters, Skylab's S190A about 30-70 meters, and its S190B about 10-30 meters. Important coastal land use details can be more readily mapped using Skylab's imagery. On the other hand, the regular eighteen day cycle of ERTS-1 allows observation of important man-made and natural changes, and facilitates collection of ground truth. The Skylab/EREP multispectral scanner offers 13 spectral bands as compared to 4 bands on ERTS-1. However, EREP scanner tapes require special filtering to remove several types of noise and their conical line scan pattern must be linearized before one can identify small targets based on spatial features.

5. Summary Outlook

The spatial and spectral resolution obtained from Skylab has exceeded our expectation. Detailed maps of coastal properties will be produced from both the digital tapes and the photographs, including coastal vegetation, current circulation patterns, suspended sediment concentration, coastal frontal systems and ocean waste disposal plumes.

6. Travel Summary

During the next reporting period one trip to Washington, D. C. and one to Bendix Aerospace Division in Ann Arbor, are planned.

7. Change of Personnel

None

Recent Publications

1. Szekielda, K. H., Kupferman, S. L., Klemas, V., Polis, D. F., Element Enrichment in Organic Films and Foam Associated with Aquatic Frontal Systems, Journal of Geophysical Research, Volume 77, No. 27, September 20, 1972.

2. Klemas, V., Detecting Oil and Measuring Oil on Water, Instrumentation Technology, September, 1972.

3. Klemas, V., Srna, R., and Treasure, W., Investigation of Coastal Processes Using ERTS-1 Satellite Imagery, American Geophysical Union Annual Fall Meeting, San Francisco, California, Dec. 4-7, 1972.

4. Klemas, V., Daiber, F., Bartlett, D., Crichton, O., Fornes, A., Application of Automated Multispectral Analysis to Delaware's Coastal Vegetation Mapping, American Society of Photogrammetry Annual Meeting, Washington, D.C., March 11-16, 1972.

5. Klemas, V., Daiber, F., Bartlett, D., Identification of Coastal Vegetation Species in ERTS-1 Imagery, Proceedings NASA ERTS-1 Symposium on Significant Results, Washington, D. C., March 5-9, 1973.

6. Klemas, V., Srna, R., Treasure, W., Applicability of ERTS-1 Imagery to the Study of Suspended Sediment and Aquatic Fronts., Proceedings of NASA ERTS-1 Symposium on Significant Results, Washington, D. C., March 5-9, 1973.

7. Kupferman, S., Klemas, V., Polis, D., and Szekielda, K., Dynamics of Aquatic Frontal Systems in Delaware Bay, A.G.U. Meeting, Washington, D. C., April 16-20, 1973.

8. Klemas, V., Srna, R., Treasure, W., Assessment of Sediment Dispersal Patterns on Delaware Bay by Use of ERTS-1 Satellite Imagery, Proceedings International Symposium on Interrelationships of Estuarine and Continental Shelp Sedimentation, Bordeaux, France, July 9-14, 1973.

9. Klemas, V., (Inivited Paper), Requirements for Laser Systems Used in Coastal Investigation, Proceedings Conference on the Use of Lasers for Hydrographic Studies, Wallops Island, Va., September 12, 1973, Sponsors NASA, NOAA, EPA, NAVY.

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12. Klemas, V., Bartlett, D., Daiber, F., Mapping Delaware's Coastal Vegetation and Land Use from Aircraft and Satellites. Proceedings A.S.P. Symposium on Remote Sensing in Oceanography, Orlando, Florida, October 2-5, 1973.

13. Klemas, V., (Invited Paper), Satellite Studies of Turbidity, Waste Disposal Plumes and Pollution - Concentrating Water Boundaries, Proceedings Second Conference on Environmental Quality Sensors, National Environmental Research Center, Las Vegas, Nevada, October 10, 1973, (Sponsor EPA).

14. Klemas, V., Bartlett, D., Rogers, R., Leed, L., Inventories of Delaware's Coastal Vegetation and Land-Use Utilizing Digital Processing of ERTS-1 Imagery, Proceedings NASA Third ERTS-1 Symposium, Washington, D. C., December 10, 1973.

15. Klemas, V., Otley, M., Davis, G., Rogers, R., Mapping Coastal Water Properties and Current Circulation with Spacecraft, Second Joint Conference on Sensing of Environmental Pollutants, Washington, D. C., December 10-12, 1973. (EPA, NOAA, NASA, DOT, ETC.).

16. Klemas, V., Otley, M., Wethe, C., Rogers, R., Application of ERTS-1 to the Management of Delaware's Coastal Resources, Proceedings NASA Third ERTS-1 Symposium, Washington, D. C., December 10-14, 1973.

17. Klemas V., Otley, M., Philpot, W., Rogers, R., Correlation of Coastal Water Turbidity and Circulation with ERTS-1 and Skylab Imagery. Proceedings Ninth Internation Symposium on Remote Sensing of Environmental, April 15-19, 1974, Ann Arbor, Michigan.

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